



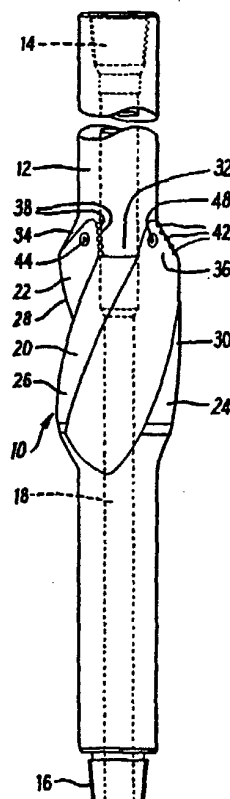
## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(54) Title: WELL DRILLING TOOLS

## (57) Abstract

A back-reaming stabiliser (10) for incorporation in a bottom-hole assembly (BHA) on the downhole end of a drillstring. The stabiliser consists of a conventional fixed-blade stabiliser having added to it rows of PDCs (38, 40, 42) or other suitable hard inserts along the upper edges of the blades (20, 22, 24) to act as back-reaming cutters, nozzles (44, 46, 48) for directing mud at these cutters during back-reaming, and a valve (50) normally closing these nozzles. The valve is opened by remote actuation immediately prior to the start of back-reaming. The valve is preferably a sleeve (50) normally held over the nozzles by shear pins (58) which are ruptured by a flow-flocking drop member (60). The drop member preferably has a through bore (76, 78) initially blocked by a burstable diaphragm (80) such that after the sleeve (50) is opened by the drop member, mud pressure can be increased to burst the diaphragm (80) and re-open a passage for mud to the downhole end of the bottom-hole assembly. This divides mud flow between an upflow past the outside of the stabiliser, and mud jets through the nozzles to the back-reaming cutters. The invention avoids the wastage of mud that would occur if the back-reaming cutter nozzles were permanently open.



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1     "Well Drilling Tools"

2

3     This invention relates to well-drilling tools, and  
4     relates more particularly but not exclusively to a  
5     well-drilling tool in the form of a back-reaming  
6     stabiliser incorporating back-reaming cutter means and  
7     valve means controllably operable to divert  
8     well-drilling fluid to said cutter means.

9

10    The back-reaming stabiliser is particularly but not  
11    exclusively applicable to the drilling of wells where  
12    the drilled formation may swell or slough into the  
13    wellbore and thereby restrict egress of the  
14    drillstring. In this context, it is known that the  
15    drilling of wells, particularly oil wells, through  
16    geological formations which are under extreme local  
17    pressures has inherent problems due to the wellbore  
18    becoming restricted by these rocks swelling or  
19    sloughing into it. In certain instances the formation  
20    will exhibit a plastic flow and may restrict the  
21    wellbore diameter over many metres.

22

23    To counteract this problem it has been common practice  
24    to use the uppermost drillstring stabiliser (furthest

1 from bit) in the BHA (bottom hole assembly) as a  
2 back-reaming stabiliser if a restriction is encountered  
3 during withdrawal of the drillstring from the wellbore.  
4 In such an instance the drillstring is withdrawn slowly  
5 from the wellbore whilst rotating at normal drilling  
6 speeds, such that the stabiliser blades cut or ream a  
7 passage back through the restricted zone. However,  
8 this has the disadvantage that the use of a drillstring  
9 stabilising element not specifically designed for a  
10 cutting operation is:-

- 11
- 12 (a) a slow and laborious, and therefore expensive  
13 operation; and
  - 14
  - 15 (b) the stabiliser is usually seriously damaged as a  
16 consequence.
- 17

18 A stabiliser which is specifically designed to have an  
19 additional back-reaming function by the provision of  
20 suitably located cutters will usually require that the  
21 cutters be supplied with mud or other appropriate  
22 well-drilling fluid for the purposes of cooling,  
23 lubrication, and debris removal. The mud will be  
24 supplied to the cutters by way of nozzles in the  
25 stabiliser. The same mud or other well-drilling fluid  
26 will be similarly supplied to the drillbit normally  
27 present at the downhole (bottom) end of the BHA.  
28 However, the drillbit and the back-reaming cutters will  
29 be required to work at mutually different times,  
30 according to whether the intended direction of progress  
31 of the drillstring is downhole or uphole. Accordingly,  
32 the simultaneous supply of mud to the drillbit and to  
33 the back-reaming cutters represents an inefficient use  
34 of the mud supply, the inefficiency manifesting itself,  
35 for example, as an unnecessarily high power consumption

1 by the mud pump. Nevertheless, the back-reaming  
2 cutters must be reliably supplied with mud or other  
3 appropriate well-drilling fluid during back-reaming  
4 operation.

5

6 It is therefore an object of the invention to provide  
7 an improved back-reaming stabiliser.

8

9 According to the present invention there is provided a  
10 back-reaming stabiliser comprising a tubular body from  
11 which a plurality of stabiliser blades extend, said  
12 tubular body having a through passage for hydraulic  
13 fluid to flow internally through said tubular body  
14 between opposite ends of said stabiliser in use  
15 thereof, said stabiliser blades extending radially  
16 outwards of said tubular body, said stabiliser blades  
17 extending longitudinally at least partially along said  
18 tubular body, said stabiliser blades extending  
19 circumferentially at least partially around said  
20 tubular body, radially outer edges of said stabiliser  
21 blades being formed as wellbore-bearing surfaces to  
22 provide a radially supportive function in use of said  
23 stabiliser, longitudinally common end edges of said  
24 stabiliser blades being formed as back-reaming cutter  
25 means, and fluid vent means coupling said through  
26 passage to the exterior of said stabiliser for the flow  
27 therethrough of hydraulic fluid from said through  
28 passage to said cutter means, said back-reaming  
29 stabiliser being characterised by further comprising  
30 valve means normally closing said fluid vent means to  
31 the flow of hydraulic fluid therethrough, said valve  
32 means being selectively operable during downhole use of  
33 said stabiliser to open said fluid vent means to the  
34 flow of hydraulic fluid therethrough.

35

1 Said valve means may comprise a sleeve means movable in  
2 said through passage between a first position of said  
3 sleeve means in which said sleeve means closes said  
4 fluid vent to the passage of hydraulic fluid  
5 therethrough, and a second position of said sleeve  
6 means in which said sleeve means opens said fluid vent  
7 means to the passage of hydraulic fluid therethrough,  
8 said sleeve means being movable from said first  
9 position thereof to said second position thereof by the  
10 application of a substantial pressure differential  
11 between longitudinally opposite ends thereof. Said  
12 sleeve means is preferably normally retained in said  
13 first position thereof by shear means rupturable by  
14 said application of said substantial pressure  
15 differential between longitudinally opposite ends of  
16 said sleeve means thereupon to release said sleeve  
17 means from said first position thereof for movement to  
18 said second position thereof. Movement of said sleeve  
19 means from said first position thereof to said second  
20 position thereof may be by way of sliding movement  
21 longitudinally along said through passage. Said sleeve  
22 means may be formed with an internal passage extending  
23 longitudinally therethrough and locally defining said  
24 through passage of said stabiliser, said substantial  
25 pressure differential being created by causing an at  
26 least temporary blockage of flow of hydraulic fluid  
27 through said internal passage extending longitudinally  
28 through said sleeve means. Such hydraulic flow  
29 blockage may be caused by manoeuvring a  
30 flow-blockage-inducing means into said internal passage  
31 through said sleeve means. Said flow-blockage-inducing  
32 means may comprise a drop means introduced to said  
33 stabiliser by being dropped into the bore of the  
34 drillstring of which the stabiliser forms part. Said  
35 drop means preferably comprises a generally tubular

1 member having a longitudinal through bore initially  
2 blocked to the passage of hydraulic fluid therethrough  
3 by a rupturable diaphragm extending thereacross, said  
4 tubular member being formed to lodge in said sleeve  
5 means, preferably by forming said tubular member with  
6 an external shoulder dimensioned to engage positively  
7 with said sleeve means which may be formed with an  
8 internal shoulder for that purpose.

9  
10 Said longitudinally common end edges of said stabiliser  
11 may be formed as said back-reaming cutter means by  
12 embedding a plurality of hard inserts in leading  
13 portions of said edges, preferably so as to lie  
14 substantially in a common notional surface of  
15 revolution, which surface may be conical. Each said  
16 hard insert may be a PDC (polycrystalline diamond  
17 compact), or a chip of tungsten carbide. Said fluid  
18 vent means may comprise a respective fluid nozzle  
19 adjacent each said cutter-formed end edge of said  
20 stabiliser blades.

21  
22 Embodiments of the invention will now be described by  
23 way of example with reference to the accompanying  
24 drawings wherein:-

25  
26 Fig 1 is an elevation of an embodiment of  
27 back-reaming stabiliser in accordance with the  
28 invention;

29  
30 Fig 2 is a plan view of the stabiliser of Fig 1;

31  
32 Fig 3 is a longitudinal section of the stabiliser  
33 of Fig 1, taken on the line III-III in Fig 2;

34  
35 Fig 4 is a transverse section of the stabiliser of

1        Fig 1, taken on the line IV-IV in Fig 3; and

2

3        Fig 5 is a longitudinal section, to a  
4        much-enlarged scale, of a drop member for use with  
5        the stabiliser of Fig 1.

6

7        Referring first to Figs 1-4 (which are different views  
8        of the same article, to a common scale), a back-reaming  
9        stabiliser 10 in accordance with the present invention  
10       is basically formed as a conventional fixed-blade  
11       stabiliser, though with certain modifications and  
12       additions (detailed subsequently) to meet the object of  
13       the invention.

14

15       The stabiliser 10 comprises an elongate tubular body 12  
16       having a standard API (American Petroleum Institute)  
17       box connector 14 at its upper end, and a standard API  
18       pin connector 16 at its lower end. The connectors 14  
19       and 16 enable the stabiliser 10 to be coupled into a  
20       BHA (bottom hole assembly; not shown), the BHA being  
21       connected to the downhole end of a drillstring (not  
22       shown).

23

24       The tubular body 12 has a through passage 18 for  
25       carrying a flow of mud (well-drilling fluid) or other  
26       hydraulic fluid between the connectors 14 and 16 in use  
27       of the stabiliser 10.

28

29       In a known manner, the body 12 is integrally formed  
30       with three stabiliser blades 20, 22 and 24 each  
31       extending radially outwards of the body 12 along a  
32       central part of its length. The blades 20-24 are  
33       equi-angularly located around the body 12 (see Figs 2  
34       and 4), and are spirally shaped (see Fig 1) such that,  
35       as a whole, the blades 20-24 extend circumferentially

1 around the body 12 to define the outer periphery of the  
2 stabiliser 10 (see Fig 2). The respective radially  
3 outer edges 26, 28 and 30 of the stabiliser blades 20,  
4 22 and 24 are formed as wellbore-bearing surfaces such  
5 that the stabiliser 10 provides the conventional  
6 radially supportive function in operation as part of a  
7 BHA.

8  
9 The respective upper ends 32, 34 and 36 of the  
10 stabiliser blades 20, 22 and 24 are formed as  
11 back-reaming cutters by being each inset with a  
12 respective row of PDCs 38, 40 and 42 which collectively  
13 sit on a notional cone coaxial with the stabiliser 10  
14 and converging upwardly. The body 12 is fitted with  
15 three radially directed nozzles 44, 46 and 38 between  
16 each of the cutter sets 38-42 (see Figs 2, 3 and 4).  
17 The nozzles 44-48 are each fed from the central through  
18 passage 18 during back-reaming, but during normal  
19 downwardly directed drilling, the nozzles 44-48 are  
20 closed off by a sleeve 50 (Figs 3 and 4) which is a  
21 sliding fit in the bore of the through passage 18. The  
22 sleeve 50 is held in a position in which it normally  
23 blocks fluid flow to the nozzles 44-48 by being secured  
24 to the lower end of a tubular mounting 52 having an  
25 external shoulder 54 which sits on a matching shoulder  
26 56 in the bore of the through passage 18. The sleeve  
27 50 is secured to the mounting 52 by means of shear pins  
28 58 (Fig 3; only one pin being visible).

29  
30 When the stabiliser 10 is required to operate as a  
31 back-reamer, it is necessary to initiate flow of  
32 well-drilling fluid outwards through the nozzles 44, 46  
33 and 48 for the reasons previously discussed.  
34 Consequently, it is necessary to slide the sleeve 50  
35 down the bore of the through passage to a position in

1     which the sleeve 50 no longer blocks fluid outflow  
2     through the nozzle 44-48. Since the stabiliser 10 will  
3     at that time be part of a BHA deep down a well, remote  
4     operation of the sleeve 50 is clearly necessary (ie  
5     direct manual movement of the sleeve 50 in such  
6     circumstances is utterly impossible). A drop member 60  
7     for achieving such remote movement of the sleeve 50  
8     will now be detailed with reference to Fig 5 (wherein  
9     the drop member 60 is depicted to a much larger scale  
10    than the stabiliser 10 is shown in Figs 1-4).

11  
12    Referring to Fig 5, the drop member 60 is generally  
13    tubular in shape and has an external diameter  
14    sufficiently small as to allow the member 60 to drop  
15    down the bore of the drillstring, and to enter the bore  
16    of the sleeve mounting 52 (Fig 3). The upper end of  
17    the drop member 60 is formed with a small external  
18    shoulder 62 dimensioned to seat on an internal shoulder  
19    64 at the lower end of the sleeve 50 (Fig 3). The  
20    external diameter of the drop member 60 below the  
21    shoulder 62 is marginally less than the internal  
22    diameter of the sleeve shoulder 64 so as to allow the  
23    drop member 60 to pass down through the sleeve 50 until  
24    the shoulder 62 seats on the sleeve shoulder 64,  
25    whereupon all further downward movement of the drop  
26    member 60 is halted.

27  
28    The drop member 60 is formed of an upper component 66  
29    and a lower component 68 which are normally mutually  
30    secured by means of a screw thread 70, a tight threaded  
31    connection of the components 66 and 68 conveniently  
32    being achieved by the application of spanners (not  
33    shown) to external flats 72 and 74. The components 66  
34    and 68 have respective longitudinal through bores 76  
35    and 78 which are initially sealed off one from the

1     other by means of a burstable diaphragm 80 clamped  
2     between the components 66 and 68 to extend fully across  
3     the bores 76 and 78.

4  
5     Operation of the invention will now be described. As  
6     described above with reference to Figs 1-4, the  
7     stabiliser 10 provides the conventional radially  
8     supportive function of the conventional fixed-blade  
9     stabiliser which it resembles, and which need not be  
10    further detailed. When required to function as a  
11    back-reamer, normal rotation of the stabiliser 10 is  
12    continued (clockwise as viewed from above, ie clockwise  
13    as viewed in Figs 2 and 4), but a suitable upforce is  
14    applied to the drillstring and through it, the upforce  
15    is applied to the BHA of which the stabiliser 10 is a  
16    part. This causes the cutter sets 42, 44 and 46 to  
17    bite into the wellbore intrusion. As already detailed,  
18    the nozzles 44, 46 and 48 have to be opened prior to  
19    commencement of back-reaming. Between the termination  
20    of down-drilling and the commencement of back-reaming,  
21    the drop member 60 is released into the bore of the  
22    drillstring to drop down or be forced by pumped mud to  
23    the stabiliser 10 wherein it passes down the through  
24    bores of the sleeve mounting 52 and of the sleeve 50,  
25    until the external drop member shoulder 62 lodges on  
26    the internal sleeve shoulder 64 to halt the downward  
27    movement of the drop member 60. In this position, the  
28    drop member 60, together with the diaphragm 80,  
29    restrict or block the flow of mud down the drillstring.  
30    When the mud-induced downforce on the drop member 60  
31    becomes sufficiently high (with increased mud pumping,  
32    if necessary), the shear pins 58 will rupture and  
33    thereby allow the sleeve 50 to be moved downwards from  
34    its initial nozzle-blocking position as shown in Fig 3,  
35    to a lower position in which the nozzles 44, 46, and 48

1 are opened for outflow of mud therethrough as  
2 previously detailed. Next, the pressure of the mud on  
3 the diaphragm 80 is increased (notwithstanding the  
4 now-commenced mud outflow through the nozzles 44-46),  
5 eg by increasing the working speed of the mud pumps  
6 (not shown), to a level at which the diaphragm 80  
7 bursts, thereby re-establishing mud flow down through  
8 the stabiliser 10 to the drillbit.

9  
10 The collective rupturing force of the shear pins 58 at  
11 any given mud pressure will be selected to be less than  
12 the equivalent rupturing force of the diaphragm 80 at  
13 the same mud pressure, ie it will be arranged that the  
14 shear pins 58 will always rupture before the diaphragm  
15 80 ruptures to ensure the intended sequence of  
16 operations.

17  
18 Mud flow down the drillstring is now split between the  
19 stabiliser nozzles 44-48 and the drillbit nozzles (not  
20 shown) in proportion to their relative flow areas, with  
21 the greater portion of mudflow preferably going through  
22 the drillbit to establish a substantial upflow of mud  
23 past the exterior of the stabiliser 10 for removal of  
24 debris arising from back-reaming operation of the  
25 cutters 38-42. The lesser portion of mudflow goes  
26 through the nozzles 44-48 to provide the cooling,  
27 lubrication, and cleaning functions previously  
28 detailed.

29  
30 As the back-reaming operation takes place the  
31 drillstring will be rotated at normal drilling speeds  
32 as it is slowly withdrawn from the wellbore. The  
33 cutters mounted on each stabiliser blade will cut and  
34 remove the formation and hence permit the egress of the  
35 BHA past the restriction.

1 The above example is cited as a simple, effective but  
2 non-repeating means of back-reaming through a wellbore  
3 restriction. By adaption of the mechanism used to  
4 divert the mud flow through the stabiliser nozzles, it  
5 would be possible to have a back-reaming stabiliser  
6 capable of back-reaming through a number of  
7 restrictions in the wellbore. This repeatability could  
8 be engendered by the use of sleeves or special valves  
9 in the stabiliser body; valves which may be activated  
10 by either hydraulic or mechanical means which would  
11 return to a detente position when the means of  
12 activation was removed.

13  
14 Whichever flow diverting valve means is used it is  
15 preferred that the through bore of the stabiliser is  
16 such that fishing and survey equipment may pass through  
17 it without impinging on the valve operating mechanism  
18 or snagging on any shoulders or ledges.

19  
20 While certain modifications and variations have been  
21 described above, the invention is not restricted  
22 thereto, and other modifications and variations can be  
23 adopted without departing from the scope of the  
24 invention as defined in the appended claims.

25

1     Claims

- 2
- 3     1.   A back-reaming stabiliser comprising a tubular  
4       body from which a plurality of stabiliser blades  
5       extend, said tubular body having a through passage  
6       for hydraulic fluid to flow internally through  
7       said tubular body between opposite ends of said  
8       stabiliser in use thereof, said stabiliser blades  
9       extending radially outwards of said tubular body,  
10      said stabiliser blades extending longitudinally at  
11      least partially along said tubular body, said  
12      stabiliser blades extending circumferentially at  
13      least partially around said tubular body, radially  
14      outer edges of said stabiliser blades being formed  
15      as wellbore-bearing surfaces to provide a radially  
16      supportive function in use of said stabiliser,  
17      longitudinally common end edges of said stabiliser  
18      blades being formed as back-reaming cutter means,  
19      and fluid vent means coupling said through passage  
20      to the exterior of said stabiliser for the flow  
21      therethrough of hydraulic fluid from said through  
22      passage to said cutter means, said back-reaming  
23      stabiliser being characterised by further  
24      comprising valve means normally closing said fluid  
25      vent means to the flow of hydraulic fluid  
26      therethrough, said valve means being selectively  
27      operable during downhole use of said stabiliser to  
28      open said fluid vent means to the flow of  
29      hydraulic fluid therethrough.
- 30
- 31    2.   A back-reaming stabiliser as claimed in Claim 1,  
32       wherein said valve means comprises a sleeve means  
33       movable in said through passage between a first  
34       position of said sleeve means in which said sleeve  
35       means closes said fluid vent to the passage of

1       hydraulic fluid therethrough, and a second  
2       position of said sleeve means in which said sleeve  
3       means opens said fluid vent means to the passage  
4       of hydraulic fluid therethrough, said sleeve means  
5       being movable from said first position thereof to  
6       said second position thereof by the application of  
7       a substantial pressure differential between  
8       longitudinally opposite ends thereof.  
9

10      3.   A back-reaming stabiliser as claimed in Claim 2,  
11       wherein said sleeve means is normally retained in  
12       said first position thereof by shear means  
13       rupturable by said application of said substantial  
14       pressure differential between longitudinally  
15       opposite ends of said sleeve means thereupon to  
16       release said sleeve means from said first position  
17       thereof for movement to said second position  
18       thereof.  
19

20      4.   A back-reaming stabiliser as claimed in Claim 2 or  
21       Claim 3, wherein movement of said sleeve means  
22       from said first position thereof to said second  
23       position thereof is by way of sliding movement  
24       longitudinally along said through passage.  
25

26      5.   A back-reaming stabiliser as claimed in Claim 2 or  
27       Claim 3 or Claim 4, wherein said sleeve means is  
28       formed with an internal passage extending  
29       longitudinally therethrough and locally defining  
30       said through passage of said stabiliser, said  
31       substantial pressure differential being created by  
32       causing an at least temporary blockage of flow of  
33       hydraulic fluid through said internal passage  
34       extending longitudinally through said sleeve  
35       means.

- 1     6.    A back-reaming stabiliser as claimed in Claim 5,  
2        wherein said hydraulic flow blockage is caused by  
3        manoeuvring a flow-blockage-inducing means into  
4        said internal passage through said sleeve means  
5        and said flow-blockage-inducing means comprises a  
6        drop means introduced to said stabiliser by being  
7        dropped into the bore of the drillstring of which  
8        the stabiliser forms part.  
9
- 10    7.    A back-reaming stabiliser as claimed in Claim 6  
11        wherein said drop means comprises a generally  
12        tubular member having a longitudinal through bore  
13        initially blocked to the passage of hydraulic  
14        fluid therethrough by a rupturable diaphragm  
15        extending thereacross, said tubular member being  
16        formed to lodge in said sleeve means.  
17
- 18    8.    A back-reaming stabiliser as claimed in Claim 7  
19        wherein said tubular member is formed with an  
20        external shoulder dimensioned to engage positively  
21        with said sleeve means.  
22
- 23    9.    A back-reaming stabiliser as claimed in any  
24        preceding claim wherein said longitudinally common  
25        end edges of said stabiliser are formed as said  
26        back-reaming cutter means by embedding a plurality  
27        of hard inserts in leading portions of said edges.  
28
- 29    10.   A back-reaming stabiliser as claimed in Claim 9  
30        wherein said inserts are located so as to lie  
31        substantially in a common notional surface of  
32        revolution.  
33
- 34    11.   A back-reaming stabiliser as claimed in Claim 10  
35        wherein said notional surface of revolution is

1 conical, and convergent in the longitudinal  
2 direction of back-reaming operation.

3

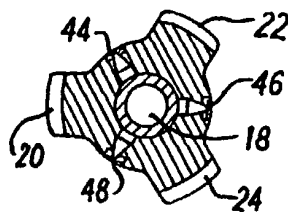
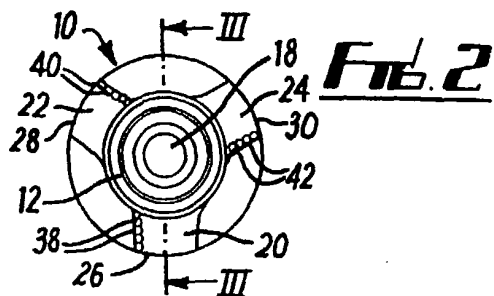
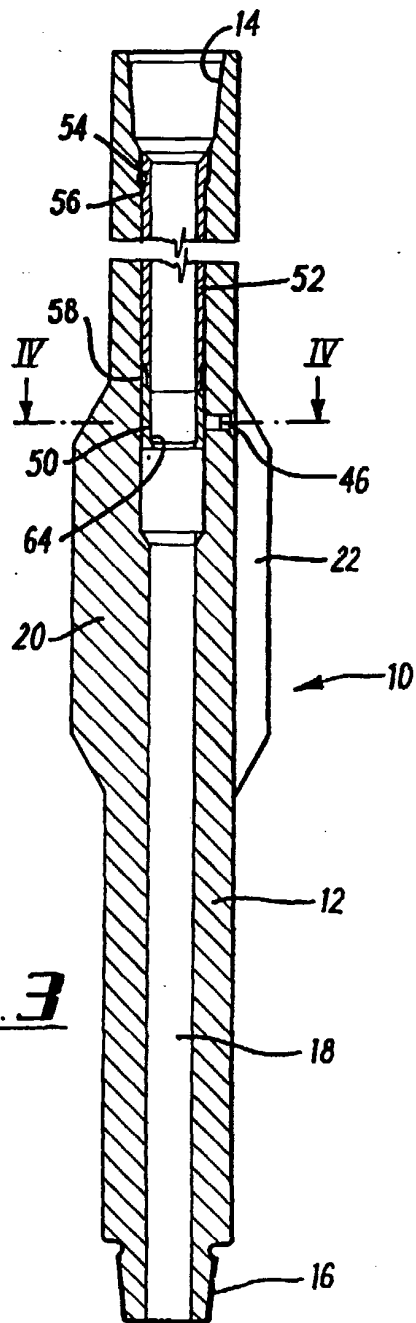
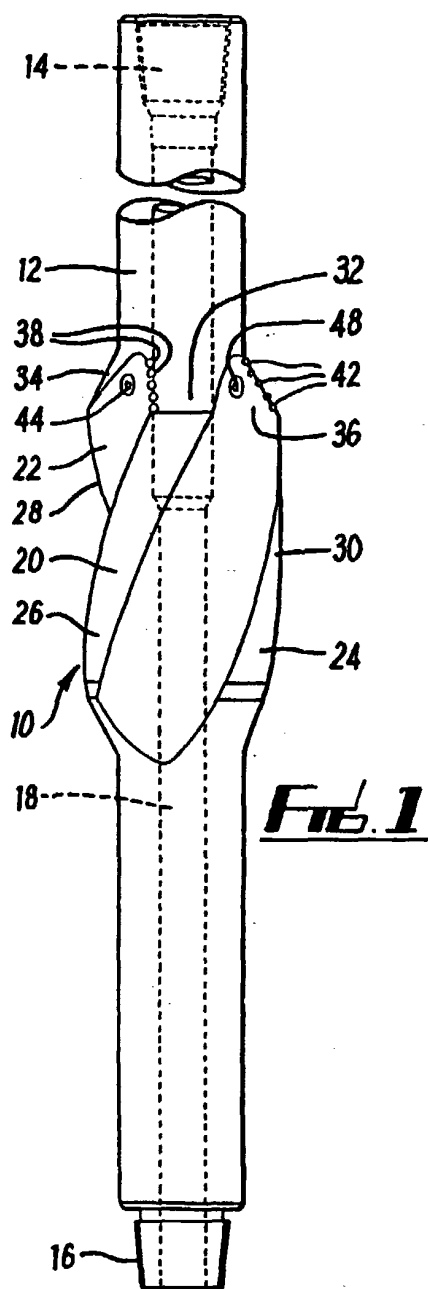
4 12. A back-reaming stabiliser as claimed in any  
5 preceding claim wherein said fluid vent means  
6 comprises a respective fluid nozzle adjacent each  
7 said cutter-formed end edge of said stabiliser  
8 blades.

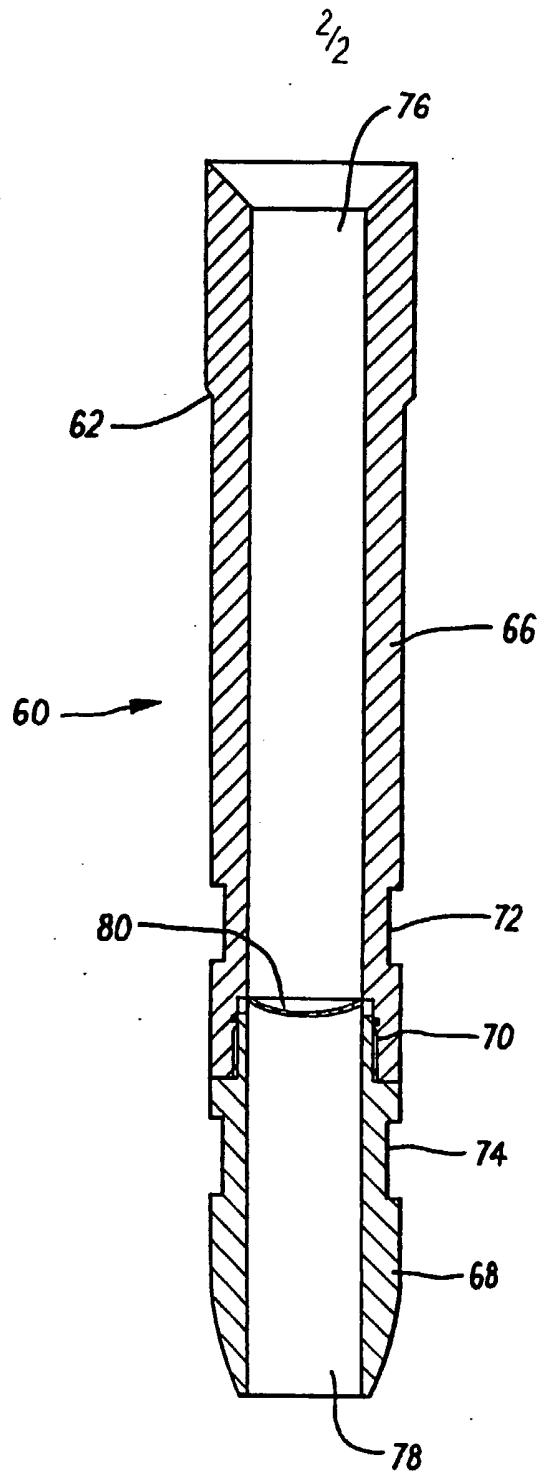
9

10 13. A back-reaming stabiliser as claimed in any  
11 preceding claim wherein said valve means is  
12 adapted for controllable cyclic operation  
13 repeatedly to open and close said fluid vent means  
14 to the flow of hydraulic fluid therethrough at  
15 selected times whereby said stabiliser may  
16 undertake plural episodes of back-reaming  
17 operation between which episodes said valve means  
18 re-closes said fluid vent means to the flow of  
19 hydraulic fluid therethrough.

20

21 14. A back-reaming stabiliser as claimed in claim 13  
22 wherein said valve means is adapted to open upon  
23 the application thereto of a valve-opening force,  
24 and to close automatically upon cessation of said  
25 valve-opening force.





**FIG. 5**

# SUBSTITUTE SHEET

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 93/01203

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (If several classification symbols apply, indicate all) <sup>6</sup>		
According to International Patent Classification (IPC) or to both National Classification and IPC		
Int.Cl. 5	E21B10/26; E21B21/10;	E21B10/60; E21B17/10; E21B34/10; E21B34/14
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>7</sup>		
Classification System	Classification Symbols	
Int.Cl. 5	E21B	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>8</sup>		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT<sup>9</sup></b>		
Category <sup>10</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>
A	US,A,4 583 603 (DORLEANS) 22 April 1986 see the whole document ---	1,9,10, 11,12
A	US,A,4 618 010 (FALGOUT) 21 October 1986 see the whole document ---	1,9-12
A	US,A,3 237 705 (WILLIAMS) 1 March 1966 see figures 2-4 ---	1
A	US,A,3 981 360 (MARATHE) 21 September 1976 see abstract; figures 2,3 ---	1-4
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<p><sup>10</sup> Special categories of cited documents : <sup>10</sup></p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&amp;" document member of the same patent family</p>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
19 OCTOBER 1993	11. 11. 93	
International Searching Authority	Signature of Authorized Officer	
EUROPEAN PATENT OFFICE	Héctor Fonseca	

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
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A	US,A,4 406 335 (KOOT) 27 September 1983 see column 4, line 24 - line 41; figures 3-5 ---	7,8
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A	US,A,4 658 902 (WESSON) 21 April 1987 -----	

**ANNEX TO THE INTERNATIONAL SEARCH REPORT  
ON INTERNATIONAL PATENT APPLICATION NO.**

GB 9301203  
SA 75783

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.  
The members are as contained in the European Patent Office EDP file on  
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

19/10/93

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